

Warren (J. C.)

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with Remarks on Trephining for
Fracture of the Base of
the Skull.*

BY

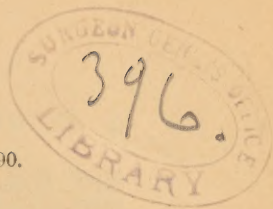
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Massachusetts General Hospital.*



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A CASE OF FRACTURE OF THE TEMPORAL BONE, WITH
REMARKS ON TREPHINING FOR FRACTURE
OF THE BASE OF THE SKULL.

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THE object of reporting this case is to call attention to the advantage of drainage as an aid to the process of repair after fracture of the base. Until quite recently this grave lesion has been regarded as beyond the pale of surgical interference. The latest literature shows, however, that hospital surgeons are endeavoring to apply the principles of antiseptic surgery to this almost inaccessible region, and the recent advances in brain surgery encourage the hope that more attention will be paid to the lesions of the different fossæ of the skull and their contents, and that valuable suggestions may from time to time be forthcoming as to the management of the complications to which they give rise.

T. K. L., seventeen years of age, a tall and slender man, was riding in the saddle about dusk of the afternoon of October 20, 1889, and had separated from his companions, having ridden rapidly ahead of them when the accident occurred. According to the statement of a passer-by, he was observed turning a corner in the road at a moderate pace, when suddenly horse and rider were seen struggling in the dust. The horse soon regained his feet and ran away. It is supposed that as the corner was turned the horse shied suddenly, throwing the rider and falling upon him.

When the patient was approached he was found to be comatose and bleeding profusely from the nose and left ear; a narrow strip of brain substance was found upon the sleeve of his coat. The accident occurred about 6 P.M. On my arrival (about 10 P.M. the same evening) I found the patient comatose with heavy breathing. There was, apparently, no paralysis of any kind; the pupils were normal and reacted to light; the pulse was of good strength and about 100 beats to the minute; hemorrhage from the nose had ceased, but the patient had vomited blood an hour or so before. Blood was still oozing from the left ear, and on close inspection two fragments of brain substance, each about the size of a pea, were found at the external auditory meatus. There was a contusion on the forehead just above the glabella, forming quite a prominent tumor. Careful examination of the scalp failed to reveal any depression of the bone. There was a boggy swelling of the integuments of the left temporal bone above and behind the ear, and a faint depression about two inches above the external meatus, which, however, was thought not to be due to displacement of bone. Pressure on these parts produced a fresh flow of

blood from the ear, the flow ceasing between the intervals of examination. No external wound was visible anywhere. The presence of brain in the discharge from the ear, the contusion of the neighboring scalp, and the profound coma pointed to serious injury at the base of the brain and in the left temporal bone.

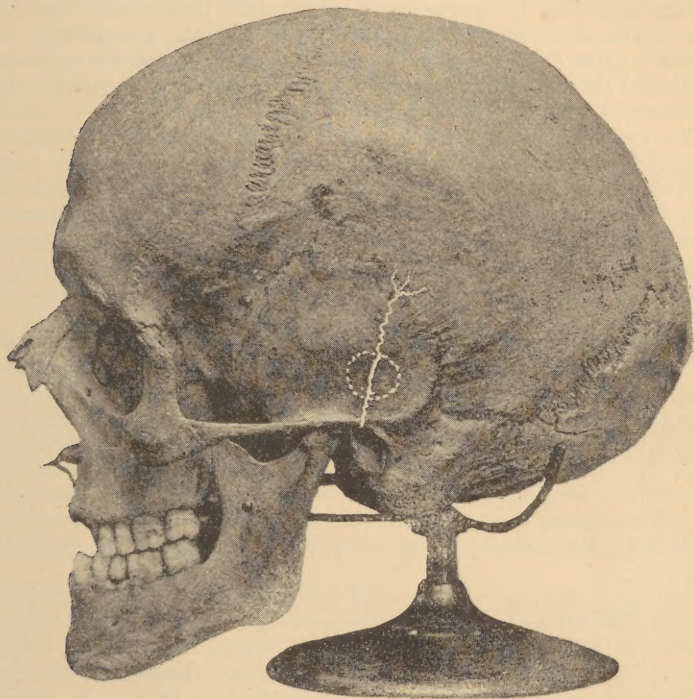
The evidence of grave injury at this spot seemed so pronounced, and the prognosis of the case seemed so unfavorable, that although no depressed fragments of bone were felt, it seemed justifiable to depart from the ordinary rule of non-interference in fracture of the base and to make an exploratory incision for the purpose of arresting hemorrhage, affording drainage, or removing clots and fragments of bone.

The operation was performed shortly after midnight—that is, about six hours after the accident—in the presence of Drs. Hall Curtis, S. J. Mixter, and John Homans, 2d., the latter having charge of the case subsequently. The scalp on this side of the head having been shaved, a curved incision was made, starting from the auriculo-bregmatic line at a point about two and one-half inches above the external auditory meatus and returning to the level of the meatus. The flap thus made, when reflected forward, exposed the posterior half of the squamous portion of the temporal bone. A nearly vertical fracture was found at about the juncture of the middle and posterior thirds of that bone: at its upper end the fracture terminated in several radiating cracks, about one-half inch in length each, which crossed the squamous suture and involved the adjacent parietal bone; it ran downward and slightly forward to the external auditory meatus, where it could be seen running along the wall of the auditory canal. (Fig. 1.) There was no depression of the bone, but the edges of the cleft were slightly sprung at the lower portion. Considerable dark-colored fluid blood with small clots welled up from beneath on slight pressure on the bone. A one-inch trephine was placed directly over the line of fracture a short distance above the meatus, and a button of bone removed, the lower edge of which was nearly on a level with the floor of the middle fossa. The dura was found torn at this point, and the finger being introduced, could follow the fracture along the petrous portion of the temporal bone, and on being turned upward found its way to the depth of the second knuckle into a lacerated wound of the middle lobe. There were a few small clots only removed from the wound, but a considerable quantity of fluid blood escaped which had evidently been confined beneath the bone; an arterial branch had been torn at this point, as shown by the groove in the button removed, and bled freely, but was easily controlled by pressure. The decalcified bone drainage-tubes which I had brought with me were found to be too much softened for use, and a strip of bichloride gauze was accordingly pushed gently along the floor of the skull, and a number of strands of catgut tied together were pushed up into the lacerated brain tissue; a small strip of gauze was placed in the auditory canal. A dressing of bichloride gauze and absorbent cotton, fortified by a folded towel wrung out of the diluted solution, was applied and held firmly in place by a figure-of-eight bandage. Antiseptic precautions were observed throughout the operation.

Immediately after the operation the patient was cold and pale and

the pulse weak; the coma remained as before; urine was passed involuntarily. During the night the dressing being stained, was reinforced. The temperature the next morning was 100.8° F., but fell to normal on the morning of the second day; he then appeared stronger. The dressing, on being changed, was found saturated with bloody serum. As it was quite a voluminous dressing, the amount of cerebro-spinal fluid and bloody discharge which it had absorbed must have been considerable. The drains were not disturbed and an iodoform gauze and absorbent

FIG. 1.



Line of the fracture through the squamous portion of the temporal bone. The dotted line shows the point at which the trephine was placed.

cotton dressing was applied. A strip of iodoform gauze was placed in the auditory canal, which at each dressing was carefully syringed out with sublimate solution, 1:5000. The temperature rose on the evening of the second day to 100.9° , the highest point reached, and fell steadily from this point to normal on the sixth day. On the fourth day the dressing was changed again: the catgut drain came away and the gauze was removed, and was replaced by a small strip of iodoform gauze inserted just within the margin of the cranial cavity; all the scalp stitches except one were removed. This dressing was allowed to remain three days, and on the 27th, just a week after the accident, all stitches and the gauze drains had been removed. During this period coma had been complete, but on this day, for the first time, the patient opened his eyes and recognized

his mother. The expected subconjunctival ecchymosis did not occur, it being evident that the effusion had had ample opportunity to escape through the drain established.

Careful attention was paid to the condition of the mucous membrane surrounding the opening of the Eustachian canal. A small amount of iodoform was blown into the left nostril with an "insufflator" once daily, and the nostril and pharynx were sprayed once or twice a day with a four per cent. solution of boracic acid. The hygiene of the mouth was also carefully attended to. It was hoped that in this way septic infection of clots in the middle ear from the side of the pharynx might be prevented. On the tenth day the gauze drain, which had been pushed less deeply into the wound, was removed altogether, and the granulating wound healed completely a few days later. A dressing of iodoform gauze was continued over the auditory meatus, which was syringed out with a sublimate wash every few days.

The mental condition of the patient during the the second week underwent little change. Beyond moaning and crying in a childish way, and staring with a puzzled expression when disturbed, there was little to indicate a knowledge of his surroundings. In the third week there was a decided improvement, the patient being able to recognize and name individuals about him and to remember me after an interval of several days. With returning consciousness a marked degree of sensory aphasia showed itself.

The temperature during this period was slightly subnormal and the pulse rose rapidly to 115 on any excitement. Sleep and appetite were, however, excellent. About this time it was noticed that the tongue, when protruded, curved slightly to the left, and the muscles of the right side of the face were not quite so powerfully contracted as those of the left. Beyond this, however, no sign of paralysis was observed anywhere. There was a slow but steady improvement in all symptoms from this time on. A statement written out by his nurse on December 6th, about six weeks after the accident, gives a good idea of his mental condition at that time:

"In language he improves and generally can easily be understood, though there are many words whose meaning he has forgotten. 'Hilarity' had to be repeated or explained several times. . . . He will sometimes talk in French or German, but cannot explain or translate it. In trying to write the shortest or simplest words he cannot remember what letters to use. . . . He often says, or asks for, things opposite to what he means; for instance, he will say, 'myself and the other girls.' In some ways his senses are keen, while in others he is very child-like."

It should be mentioned in this connection that the patient had been a brilliant scholar.

On December 8th the ear was examined by Dr. Clarence J. Blake, who made the following report: "The walls of the canal are but slightly reddened; there is very little discharge from the ear, and the hearing is gratifyingly good, as the tuning-fork which he heard sixty-five seconds in the sound ear is heard between thirty-five and forty seconds in the left ear. By bone conduction the fork is heard better in the left ear. In this ear also the hearing for high tones remains as good as could be expected under the existing conditions, including rupture of the membrana tympani. The condition of the ear indicates fracture of the superior wall of the

external canal longitudinally and rupture of the membrana tympani, but no injury to the labyrinth."

There is little to be said about the further progress of the case, except that the mental improvement was rapid during the month of December, and by January 1st the aphasia had almost entirely disappeared. Under date of March 2d Dr. John Homans, 2d., writes me: "The tongue is still protruded slightly to the left; there are some hesitancy and stammering in the speech and an incapability of continuous mental exertion—that is, he cannot read aloud for more than half an hour without mispronouncing badly and having slight pain in the head, but in all these defects there is a steady, though slow, improvement."

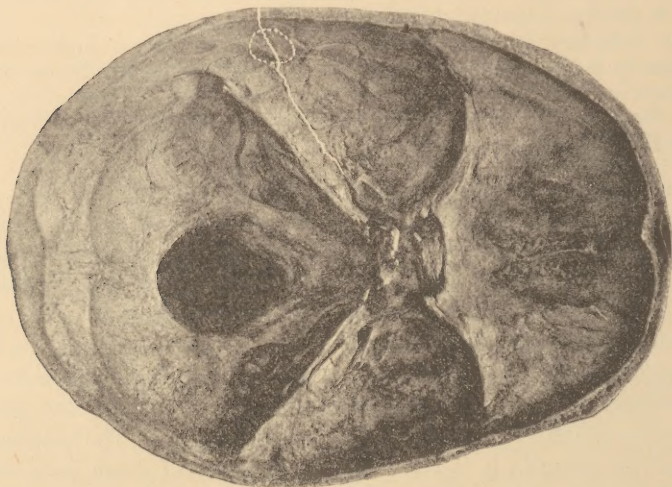
On February 4th Dr. Blake writes: "To-day young L. has no discharge from the ear, the granulations have disappeared, the membrana tympani is intact, but somewhat opaque, from the thickening of the inner coat, the Eustachian tube is free, and the hearing after catheterization is for a Politzer acoumeter $\frac{65}{180}$."

The question of diagnosis is of importance in this case, as it is, of course, desirable to determine definitely whether we have a "fracture of the base" to deal with. So far as the appearances observed within the ear and the complete restoration of the hearing serve as evidence, it would appear that there had been a widely spreading fracture of the superior wall of the bony external auditory canal, stopping at the inner end of the canal. But such an assumption is highly improbable when we consider the anatomical peculiarities of the temporal bone and the structures which lie in the direct line of the fracture. The petrous portion of the bone is, it is true, largely composed of dense bony tissues, but the bony covering of the middle ear, which lies in the anterior portion of the petrous portion and near its junction with the squamous portion, is extremely thin. There are other structures which tend to make the bone particularly weak at this point.

Passing a probe through the Eustachian tube and the auditory canal of a dry specimen, and looking at the under surface of such a bone, we see that the probe marks a line of division between the squamous portion on the one side and the mastoid and petrous portions on the other. Along this line lie the canals for the Eustachian tube and tensor tympani muscle, the external auditory canal, and the Glaserian fissure. The carotid canal, although not on this exact line, is quite near it, and weakens this portion of the petrous bone. A fracture descending from the squamous portion and passing along the wall of the external auditory canal, parallel with its long axis, would, if continued onward in the same line, pass through the structures just mentioned; and, moreover, piercing the membrane of Schrapnell would pass in front of the apparatus for hearing. It is true that rupture of this membrane implies the opening of the tympanic cavity, but the membrana tympani is placed at an extremely oblique angle with the long axis of the canal, which runs forward and inward, and a longitudinal fracture through the roof of the canal, if

continued in the same direction, would rupture the membrane of Schrapnell, traverse the anterior portion of the tympanic-cavity, and, avoiding the delicate structures of the middle ear, terminate somewhere in the angle between the petrous and the squamous portions of the bone—that is, at the point where the temporal bone articulates with the posterior angle of the great wing of the sphenoid bone. (Fig. 2.)

FIG. 2.



The probable route of the fracture terminating in the carotid canal at the margin of the foramen lacerum medium. The dotted circle shows the seat of the trephine hole.

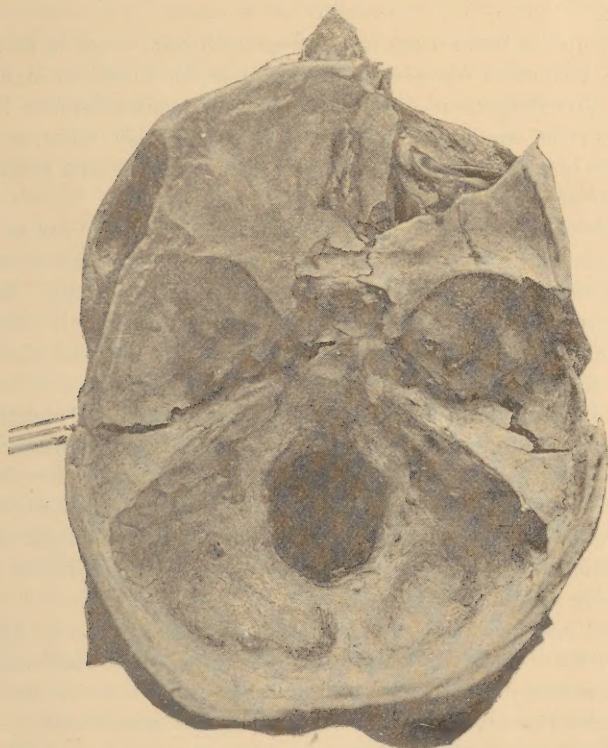
Experiments on the cadaver to show what kind of violence probably caused the lesion of our patient demonstrated that such fractures could be produced by blows with a blunt instrument applied directly above the external auditory meatus.

The head of a fresh cadaver was tested in this way in the autopsy-room and a number of dissecting-room subjects were also used for this purpose. In all cases the fracture ran down the anterior and external portions of the petrous bone to terminate either in the external margin of the foramen lacerum medium or the junction of the posterior angle of the great wing of the sphenoid with the temporal bone—that is, near the foramen spinosum through which the meningeal artery passes. In some cases the broken edges were closely in contact; occasionally the fissure was broad so that one could look down into the tympanic cavity where the bones of the ear could be seen still maintaining their normal positions. (Fig. 3.)

It seems highly probable, therefore, that this is the type of fracture ordinarily produced by blows received over the external ear. But in

the present case the bone was not only broken, but the brain was also severely lacerated and the dura ruptured. My explanation of the injury is as follows: In falling from his horse the patient struck upon the forehead producing the contusion already noted. This accounted, probably, largely for the hemorrhage from the nose and vomiting of blood. The horse in falling struck him a severe blow on the side of the head, producing the fracture of the temporal bone, and at the same time the weight of the animal pressing heavily upon the cranium, forced apart the edges of the fracture and forced out the cranial contents, rupturing the dura. As the bones sprang back into place the protruded brain was nipped and expelled through the ear, thus accounting for the narrow strip of brain found on the patient's coat-sleeve.

FIG. 3.



Fractures through the petrous bones into the foramen lacerum medium on each side, produced experimentally by blow of a mallet before opening the head. A glass rod is placed in the left external auditory canal.

The laceration of the brain extended deeply into the middle lobe, reaching as far as the first temporo-sphenoidal convolution and possibly

involving a portion of the inferior frontal convolution. The lesion must have involved the peripheral portions of the centre for speech, and the effects of the injury must have been felt as far as the centres for the face and tongue.

We have in this case an example of fracture of the temporal bone, involving the base and communicating with the external and middle ear, and possibly the Eustachian canal, but not opening directly into the vault of the pharynx. As a complication, we have laceration of the middle lobe and rupture of the posterior branch of the middle meningeal artery.

The symptoms of fracture of the base were characteristic, consisting of profound coma, bleeding from the ear, and the escape of brain-substance. The presence of cerebro-spinal fluid was not noticed at the time of the injury, owing to the free hemorrhage, and later was, naturally, not seen flowing from the ear, owing to the establishment of suitable drainage.

The escape of brain-tissue is not a common occurrence in fractures of the base, but when observed is regarded as an unfailing sign of that lesion. Von Bergmann¹ says: The escape of brain-substance from the fracture of the base is an undoubted symptom of this injury, and at the same time of laceration of the membranes; it may escape from the external ear or the nose.

Nancrede² says: The escape of brain-substance by the ear or nose, of course, definitely settles the fact of basal fracture, but is of rare occurrence.

The treatment of fractures of the base, until recently, has been largely expectant. Even long after antiseptic treatment of wounds had been established, surgeons do not appear to have realized that in this form of fracture they often had a compound fracture to deal with. Recent literature, however, has taken cognizance of the claims of this region to the benefits of antiseptics. Keen³ advises disinfection of the ear, filling it with boracic acid, and covering the scalp with sublimate gauze. He recommends opening the roof of the orbit or nostril in penetrating wounds of those regions, to provide for free drainage. He also advises tamponing the nostrils with sublimate gauze to prevent passage of infective air through these passages.

Dennis⁴ lays down rules for the treatment of this fracture. He thinks the entire scalp should be shaved and disinfected. He also irrigates the external auditory canal and the nasal passages. "Both of these should be rendered thoroughly aseptic, after which the ears should be packed with iodoform or bichloride gauze, and some absorbent cotton plugs placed in the nose."

¹ Deutsche Chirurgie, Lieferung, 30.

² International Encyclopædia of Surgery, vol. v.

³ Handbook of Medical Science, vol. viii. p. 226.

⁴ The Medical Record, November 23, 1889.

In the case reported here every effort was made to prevent infection through the Eustachian tube. The epistaxis and hematemesis in this case may have been due, in part, to the flow of blood from this canal. It was, in any event, important to keep the inner opening to the middle ear in as aseptic a condition as possible.

This can hardly be accomplished by gauze or cotton plugs in the nose unless they are brought in direct contact with the mouth of the Eustachian tube.

Rosenbach has shown that the pharynx is a not infrequent seat of the pyogenic cocci, and the antisepsis of this region must, consequently, also be carefully attended to.

Frequent douching of the naso-pharynx and mouth with antiseptic sprays is perhaps as efficient and safe a method as any. At the Boston City Hospital diphtheria patients are sprayed hourly in this way with a 1 : 1000 solution of sublimate given with an insufflator, and often without waking the patient. A little iodoform powder dusted once a day on to the membrane near the Eustachian opening may aid in preserving the region in an antiseptic condition. Should a more extensive fracture, such as one crossing the vault of the pharynx, exist, it might be advisable to plug the pharynx and posterior nares with antiseptic gauze. Such a dressing would be no annoyance to a comatose patient, and it is difficult to see how a fracture of this region could be dressed antiseptically in any other way.

The use of the trephine has been recommended for depressed fractures of the base, but has not been frequently employed, and then only in the occipital region. Hutchison¹ has applied the trephine successfully near the foramen magnum for a depressed fracture of that region in a boy fourteen years of age; puncture of the membrane was subsequently resorted to for a serous effusion, and recovery took place.

Keen recommends an opening for drainage in the roof of the orbit in punctured wounds at that point. Allis (*Annals of Surgery*, July, 1889) drilled through the cribriform plate for drainage of a compound depressed fracture of the frontal bone situated an inch above the right eye—a drainage tube three-eighths of an inch in diameter was passed through the openings. The patient recovered.

Trephining for drainage in fractures of the base is a device which I do not find mentioned in a moderate search through the literature of this subject, and its successful application to Dr. Homans's patient seems to me of sufficient importance alone to justify placing the case on record.

Applied just above the external auditory meatus the instrument makes an opening which drains most effectually the middle fossa. This operation would, therefore, be applicable not only to fractures of the temporal

¹ Medico-Chirurgical Transactions, vol. ii. p. 105.

bone but fractures through the sphenoid, and even those involving the anterior fossa. For this latter region, however, it would probably be desirable to place the trephine near the pterion, as injuries to the middle meningeal artery might thus also be attended to.

In fractures of the occipital bone the opening should be made below the insertion of the tentorium in order to drain the posterior fossa, and care should be taken to avoid the lateral and occipital sinuses. The trephine should, therefore, be placed below the superior curved line, and not too near the crest of the occiput.

Recently I had an opportunity to see two autopsies of cases of fracture of the base. In one case there was a partially detached fragment of the occiput half-way between the foramen magnum and superior curved line. The fragment could not be removed, owing to severe hemorrhage from the lateral sinus, and the surgeon had left the parts so as to favor drainage. On opening the skull but a small amount of extravasated blood was found in the pia mater of the cerebellum and medulla. In a second case where the sinuses had also been ruptured and no opening for drainage had been made, the entire surface of the brain was covered with extravasated blood.

In a fracture clearly involving the vault of the pharynx, even though it were not possible to say that the temporal bone had been injured, the trephine might be placed a little anterior to the auriculo-bregmatic line and a gauze drain inserted along the floor of the skull in the route of the fissured bone. A case can even be imagined where it would be proper to place the trephine upon the squamous portion of each temporal bone in order that the entire region of the sphenoid bone might thus be controlled by the drainage gauze.

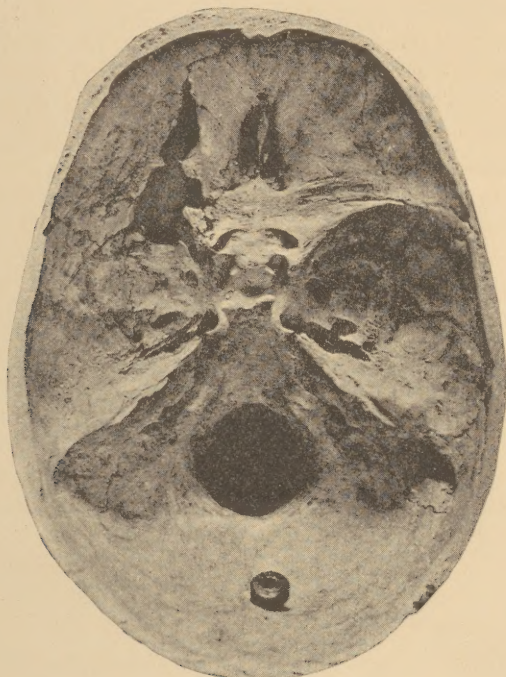
The materials used as drains in surgery of the brain should, it seems to me, differ essentially from those used ordinarily for this purpose elsewhere. The sharp edges of bone or rubber drains are sources of irritation and may even destroy brain substance by pressure. Catgut may be absorbed too soon, but otherwise works well. Horse-hair may be suited for the scalp, but could not easily be introduced into a lacerated wound of the brain-tissue without danger of irritation from the sharp points.

The antiseptic gauze used in my case seemed to meet all requirements. It can be easily slipped along the inner surface of the dura and constitutes not only a drain, but also an antiseptic dressing, which protects the cranial contents from invasion from the naso-pharyngeal cavities or the ear. It can drain, not only the wound, but may absorb from the subdural space fluid which accumulates on either side of the dressing, and by capillary attraction aspirate the exudation from different directions.

No better illustration of the advantages of drainage for fractures of

the base could be given than that afforded by the celebrated tamping iron case. (Fig. 4.) Dr. Harlow¹ thus describes the opening made through the floor of the skull :

FIG. 4.



Photograph of the base of the skull of the tamping iron case, showing the hole made by the iron in its passage through the frontal and sphenoid bones.

"The missile . . . entered the base of the skull at a point, the centre of which is one and one-fourth inches to the left of the median line, in the junction of the lesser wing of the sphenoid with the orbital process of the frontal bone, comminuting and removing the entire lesser wing with one-half of the greater wing of the sphenoid bone; also fracturing and carrying away a large portion of the orbital process of the frontal bone, leaving an opening in the base of the cranium, after the natural efforts at repair by the deposit of new bone, of one inch in its lateral by two inches in its antero-posterior diameter."

In his remarks upon the case he says:

"The bolt did little injury until it reached the floor of the cranium, when, at the same time that it did irreparable mischief, it opened up its way of escape, as without this opening in the base of the skull, for drainage, recovery would have been impossible."

¹ Passage of an iron bar through the head. Read before the Massachusetts Medical Society, June 31, 1868. John M. Harlow, M.D.

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